Flight Planning Annex

Shuttle Ionospheric Modification with Pulsed Localized Exhaust (Flight Activity Planning)

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DESCRIPTION OF CHANGES TO

FLIGHT PLANNING ANNEX

FLIGHT ACTIVITY PLANNING

ANNEX 2 - PART II

SHUTTLE IONOSPHERIC MODIFICATION WITH PULSED LOCALIZED EXHAUST

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ANNEX 2 - PART II

SHUTTLE IONOSPHERIC MODIFICATION WITH PULSED LOCALIZED EXHAUST

MARCH 3, 1997

Signed by Gustavo A. Hernandez,
dated 01/03/97
CAPT. GUSTAVO A. HERNANDEZ, USAF
PAYLOAD REPRESENTATIVE

Signed by Robert H. Nute,
dated 03/03/97
ROBERT H. NUTE
FLIGHT ACTIVITY PLANNING
ANNEX BOOK MANAGER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

PREFACE

The Flight Planning Annex (FPA) contains agreements between the customer and the Space Shuttle Program (SSP) on matters which relate to the implementation of payload flight design requirements on the SSP; i.e., part I - payload electrical power, energy, cooling, and Orbiter support equipment usage requirements; part II - crew-related activities; part III - trajectory design and deploy target considerations. The basic requirements are stated in the Payload Integration Plan (PIP). This document is intended to supplement the PIP in providing additional details to facilitate mission and flight operations within the scope of the task areas and responsibilities specified in the PIP.

In case of conflict between this document and the PIP, the PIP shall govern. Any requirements submitted in this document which are outside the scope of tasks or responsibilities defined in the PIP shall be considered nonbinding on the SSP.

Data submissions, questions, and/or comments relative to this annex should be directed to the appropriate book manager:

Part II: Douglas Bristol, DO4, National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center (JSC), Houston, TX 77058, 281-244-1148

The customer point(s) of contact for this annex are as follows:

Part II: Capt. Gustavo Hernandez USAF, ZR-1, SMC/TELH (OLAW) JSC, Houston, TX 77058, 281-483-3425

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1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center (JSC) will be responsible for Flight Plan development and will provide an integrated Space Shuttle/payload Flight Plan to support the flight. The following data requirements are provided by the customer for development of the Flight Plan.

2.0 FLIGHT ACTIVITY REQUIREMENTS

The Shuttle Ionospheric Modification with Pulsed Localized Exhaust (SIMPLEX) requires cooperative Orbiter Orbiter Maneuvering Subsystem (OMS) firings over three different ground-based radar sites. There is no flight hardware required for the SIMPLEX payload. Flight control personnel will be required to identify and plan cooperative opportunities and the crew will be required to attain/maintain attitude and perform OMS firings at designated times over the radar sites.

2.1 Payload/Crew Activity Requirements

The SIMPLEX payload requires the Orbiter to fire an OMS engine above a ground based radar site. Above each site the Orbiter will perform a Ram, Wake, and 90° burn. Two burns of each type are required; one burn with the Orbiter and the radar site in darkness and one burn with the Orbiter and the radar site in sunlight. Both the Orbiter and the site must be in the same lighting conditions at the time of the test. There are no priorities to the above tests.

A good contact for the radar site will occur when the Orbiter penetrates an imaginary cylinder rising above the site; the axis of the cylinder centered on the radar site and the base of the cylinder on the plane of the surface of the Earth. The radius of the cylinder is dependent on the altitude of the Orbiter. The radius of the cylinder is defined as: Orbiter altitude (in Km) X tan 50°. The higher the altitude the larger the radius.

Setup for the SIMPLEX OMS firings will require the Orbiter crew to maneuver the Orbiter into a predetermined attitude. Fifteen minutes are allotted for this activity. It is desired that the Orbiter be in the test attitude for at least 1 minute before the test.

The crew will then initiate a 12-second OMS burn in the desired attitude at the time specified in the Flight Plan by SIMPLEX. If there is insufficient propellant available for a 12-second burn, the Principal Investigator (PI) may settle for a smaller duration burn.

The crew will then hold attitude for 1 minute after completion of the burn.

Then the crew will maneuver the Orbiter to its nominal attitude. Fifteen minutes are allotted for this activity. The payload/crew activity requirements for the SIMPLEX tests are contained in table 2-1. The test conditions are contained in table 2-2.

2.2 Attitude and Pointing Requirements

The SIMPLEX payload requires the OMS thrust vector to be aligned to the Orbiter's velocity vector. Thrust angles should be as close as possible to the desired orientation. The desired attitudes do not require a rotation rate or an angular acceleration.

The 90° burn desires a -XLV ±YVV, or -XLV ±ZVV attitude with the thrust vector of the OMS engine at 90° to the Orbiter velocity vector. A ±10° deadband is desired.

The Ram burn desires a -XVV attitude with the thrust vector of the OMS engine at 0° to the Orbiter velocity vector. A ±10° deadband is desired

The Wake burn desires a +XVV attitude with the thrust vector of the OMS engine at 0° to the Orbiter velocity vector. A ±10° deadband is desired.

It is desired that the Orbiter be in attitude at least 1 minute prior to the OMS firing and stay in attitude at least 1 minute after the OMS firing.

The payload attitude and pointing requirements are contained in table 2-3 and shown in figure 2-1. All attitudes are referenced to the Orbiter body coordinate system.

The three radar sites used by the SIMPLEX payload are contained in table 2-4. Figure 2-2 shows their locations on the world map.

2.3 Contamination Avoidance

The SIMPLEX payload desires that there be no water dumps or fuel cell purges during all tests. Also the Flash Evaporator System (FES) should be inhibited at the time of the test.

Contamination avoidance is desired at least 15 minutes prior to the test through 5 minutes after the test.

Contamination sources that are to be inhibited during SIMPLEX tests are summarized in table 2-5.

Table 2-1.- PAYLOAD/CREW ACTIVITY REQUIREMENTS

Flt phase/ event or PET (HR:MIN)	Payload activity title	Command source	Payload activity duration (HR:MIN)	Crew activity requirements* (HR:MIN)	Comments/ constraints
All tests	Setup	Crew	00:15:00	Maneuver to attitude as defined in table 2-4.	Highly desire FES inhibited, no fuel cell purges, and no water dumps during test operation (≈15 minutes).
	Test	Crew	00:00:12	At TIG: initiate a 12-second OMS burn. The PI may accept a smaller duration burn if insufficient propellant is available.	Use OMS engine lined up with the Orbiter Velocity Vector (VV) as defined in figure 2-1.
	Postburn	Crew	00:01:00	Hold attitude.	
	Cleanup	Crew	00:15:00	Return to nominal attitude.	

Table 2-2.- TEST CONDITIONS

Test number	Orientation	Lighting
1	Ram	Night
2	Wake	Night
3	90°	Night
4	Ram	Day
5	Wake	Day
6	90°	Day

Note: The Ram, Wake, and 90° indicate the relative direction between the OMS thrust vector and the Orbiter VV. There are no priorities to the above tests. Each of the three SIMPLEX sites requires one each of the above tests.

Table 2-3.- ATTITUDE AND POINTING REQUIREMENTS

Payload activity title	Orient-ation	Mnvr/rot rate	Deadbands	Ang accel	Remarks
OMS 90^0 Burn TIG - 1 minute	-XLV ±YVV or -XLV ±ZVV with thrust vector of OMS engine at 90° to the Orbiter VV	None	±10°	None	Desire -XLV attitudes and to be in attitude and holding at least 1 minute prior to OMS firing. Desire a wait of at least 1 minute after OMS burn to return to attitude.
OMS RAM Burn TIG - 1 minute	-XVV with thrust vector of OMS engine at 0° to the Orbiter VV	None	±10°	None	Desire to be in attitude and holding at least 1 minute prior to OMS firing. Desire a wait of at least 1 minute after OMS burn to return to attitude.
OMS WAKE Burn TIG - 1 minute	+XVV with thrust vector of OMS engine at 180° to the Orbiter VV	None	±10°	None	Desire to be in attitude and holding at least 1 minute prior to OMS firing. Desire a wait of at least 1 minute after OMS burn to return to attitude.

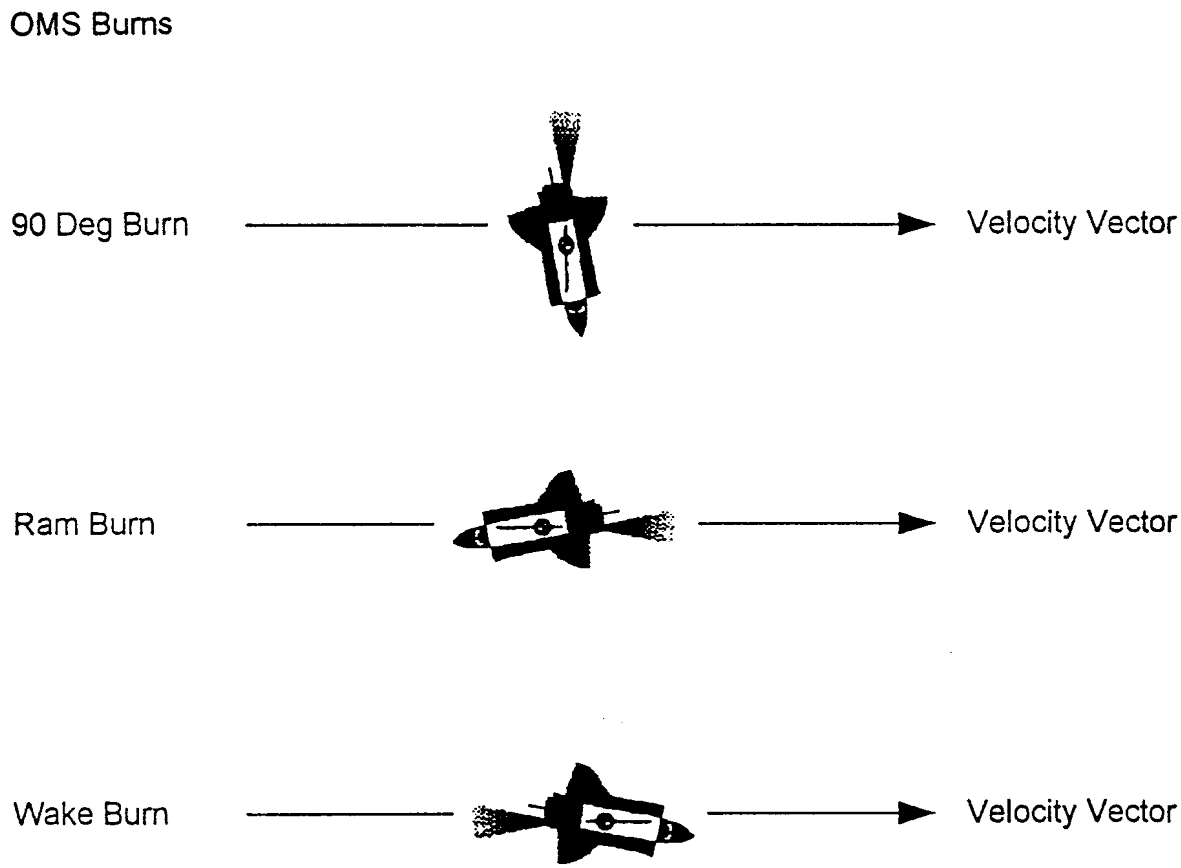

Figure 2-1.- Example Orbiter firing orientations.

Table 2-4.- SIMPLEX RADAR SITES

Site	Location (latitude, longitude)
Arecibo	18.34° N, 66.74° W
Jicamarca	11.95° S, 76.87° W
Kwajalein	8.72° N, 167.72° W

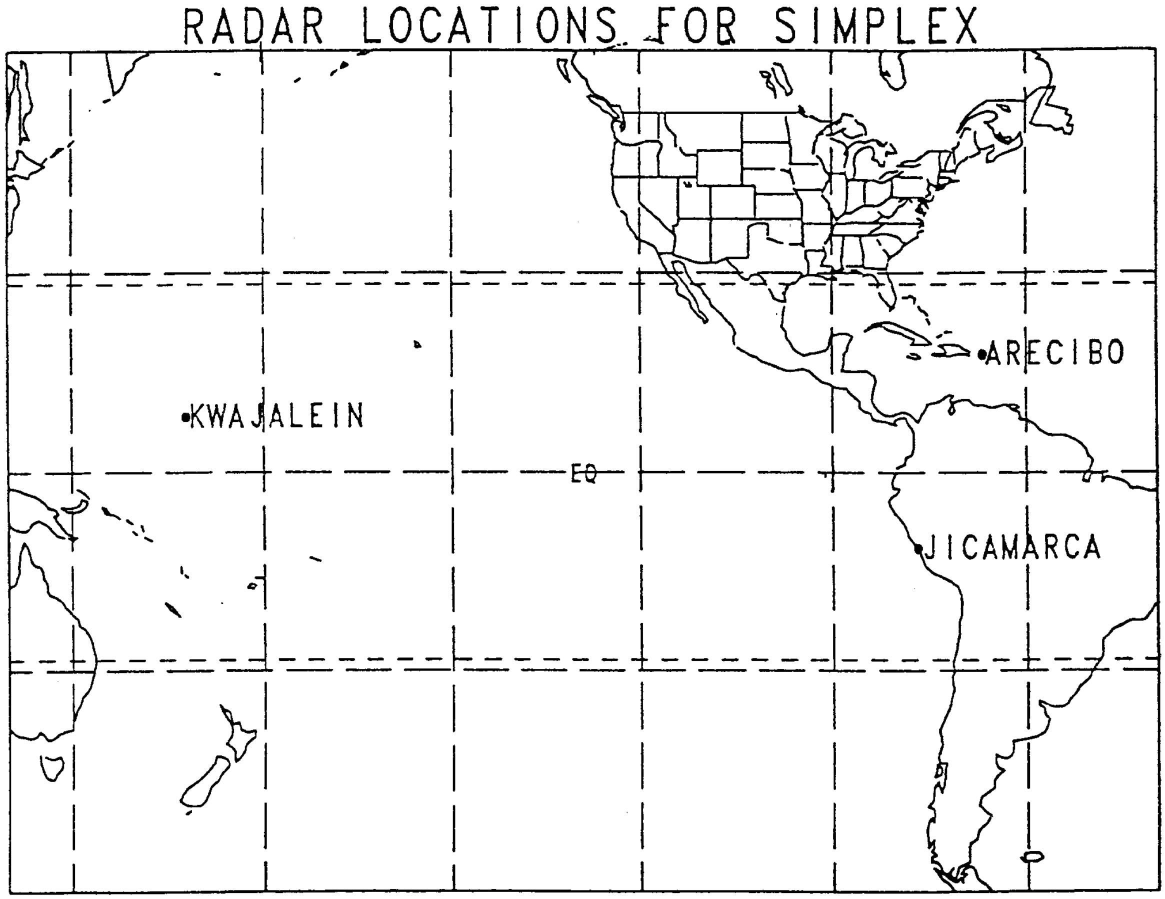

Figure 2-2.- Simplex radar sites.

Table 2-5.- CONTAMINATION AVOIDANCE

Payload activity title	Contamination constraints	Avoidance interval	Remarks
All Tests	FES inhibited, no water dumps or fuel cell purges	Desire at least 15 minutes prior to test through 5 minutes after the test.	

APPENDIX A

ACRONYMS AND ABBREVIATIONS

Accel	Acceleration
Alt	Altitude
Ang	Angular
Att	Attitude
FES	Flash Evaporator System
FPA	Flight Planning Annex (PIP Annex 2)
FRD	Flight Requirements Document
Km	Kilometer
JSC	Lyndon B. Johnson Space Center
Lat	Latitude
Lon	Longitude
LVLH	Local Vertical/Local Horizontal
MET	Mission Elapsed Time
min	minute
MNVR	Maneuver
NASA	National Aeronautics and Space Administration
n. mi.	nautical mile
OMS	Orbiter Maneuvering Subsystem
PET	Phase Elapsed Time
PI	Principal Investigator
PIP	Payload Integration Plan
PRCS	Primary Reaction Control System
RCS	Reaction Control System
sec	second
SSP	Space Shuttle Program
VERN	Vernier Jets
VV	Velocity Vector

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